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**Competitive Research Grant**

**Sub-Project Completion Report**

**on**

**Evaluation of endocrine biopesticides against  
major sucking insect pests of vegetables**

**Project Duration**

**May 2017 to September 2018**

**Department of Entomology  
Bangladesh Agricultural University  
Mymensingh-2202**



**Submitted to**  
**Project Implementation Unit-BARC, NATP 2**  
**Bangladesh Agricultural Research Council**  
**Farmgate, Dhaka-1215**



**September 2018**

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**Project Title: Evaluation of endocrine biopesticides against major sucking insect pests of vegetables**

Project Implementation Unit  
National Agricultural Technology Program-Phase II Project (NATP-2)  
Bangladesh Agricultural Research Council (BARC)  
New Airport Road, Farmgate, Dhaka – 1215  
Bangladesh

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## Acronyms

BAU	Bangladesh Agricultural University
DAT	Days After Treatment
DAST	Days After Seedlings Transplantation
ml	Milliliter
CV	Co-efficient of Variation
P-level	Probability level
/	Per
EC	Emulsifiable Concentrate
SC	Soluble Concentrate
IPM	Integrated Pest Management
IGR	Integrated Pest Management
a.i.	Active Ingredient

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## Executive Summary

Bangladesh has made significant progress in vegetable production as well as export. Most of the vegetables are severely infested by different kinds of insects with various modes of feeding like piercing and sucking, internally feeding (borer), chewing etc. Sucking insect pests like thrips, jassid, aphid, white fly etc. are main constraints for vegetable production in Bangladesh as these pests damage plants by sucking sap from plants, injecting toxic materials into the plant system while feeding, and transmission of disease organisms like viruses. Vegetable growers extensively depend on chemical pesticides to counter the problem of these insect pests. In the present study, some endocrine biopesticides viz. Buprofezin (Award 40 SC), Pyriproxifen (Pyrifen 10.8 EC), Lufenuron (Heron 5 EC) and Chitosan were evaluated against major sucking insect pests like aphid, jassid, white fly thrips etc both in the laboratory as well as in the field condition. Laboratory data clearly showed that about 80-90% sucking insects were died due to the effect of Award, Pyrifen and Heron. In contrast, chitosan was found to be very ineffective against sucking insects. Growth and development was potentially inhibited (30-40%) due to the effect of Award, Pyrifen and Heron. Among three application methods, combined application method was found to be very potential which was followed by leaf-dip and direct application method. In case of field experiments, the incidence of bean aphid, jassids and white fly was very low (1-2/leaf) at three weeks after treatments application. In contrast, chitosan had no significant effect on reduction of sucking insects compared to control. Numbers of sucking insects were gradually decreased with increasing spray numbers and the lowest incidence was found in the third spray. Based on laboratory and field experiments it may be concluded that the IGRs Award 40 SC (Buprofezin), Pyrifen 10.8 EC (Pyriproxifen) and Heron 5 EC (Lufenuron) might be the potential alternate of conventional high residual insecticides. Their efficacy may be increased further if these IGRs are tagged with IPM packages. Chitosan is not recommended for the sucking insect's viz. aphid, jassid, thrips and white fly. More experiments may be needed in different agro-ecological zones to confirm the consistency of the selected endocrine bio-pesticides especially Award 40 SC, Pyrifen 10.8 EC and Heron 5 EC against selected sucking insects. From this study, it can be concluded that the selected endocrine biopesticides like Buprofezin (Award 40 SC), Pyriproxifen (Pyrifen 10.8 EC) and Lufenuron (Heron 5 EC) would be the promising and potential alternatives of conventional insecticides to control sucking insects like jassids, aphid, white fly, thrips etc on different vegetables like brinjal, okra, bean etc.

## CRG Sub-Project Completion Report (PCR)

### A. Sub-project Description

1. Title of the CRG sub-project: Evaluation of endocrine biopesticides against major sucking insect pests of vegetables.
2. Implementing organization: Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202.
3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

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4. Sub-project budget (Tk):
  - 4.1 Total: 15,91,135.00 Tk
  - 4.2 Revised (if any):
5. Duration of the sub-project: May-2017 to September-2018
  - 5.1 Start date (based on LoA signed): 08 May, 2017
  - 5.2 End date: 30 September 2018

## 6. Justification of undertaking the sub-project:

### Present status and severity of the problem:

Bangladesh has made significant progress in vegetable production as well as export. According to FAO, vegetable production has increased five times in the past 40 years. Bangladesh has scored 3<sup>rd</sup> in global vegetable production, next to China and India. However, insect pests are the major biotic constraints to vegetables production in Bangladesh. Vegetables are severely infested by different kinds of insects with various modes of feeding like piercing and sucking, internally feeding (borer), chewing etc. Sucking insect pests like thrips, jassid, aphid, white fly etc. are main constraints for vegetable production in Bangladesh as these pests damage plants by sucking sap from plants, injecting toxic materials into the plant system while feeding, and transmission of disease organisms like viruses (Shivalingswami *et al.* 2002).

However, in recent years, with changes in the cropping systems and climate, and introduction of high yielding varieties/hybrids has resulted in dramatic changes in pest scenario leading to minor pests assuming major status especially sucking pests like whiteflies, jassids, thrips and aphids. Both nymphs and adults of these hemipteran pests suck the sap from the lower leaf surfaces through their piercing and sucking mouthparts and all of them are polyphagous, mostly infesting brinjal, okra, tomato, bean, peppers and cucurbits (Shrinivasan and Babu, 2001). In addition, they disrupt transportation in conducting vessels and apparently introduce a toxin that impairs photosynthesis in proportion to the amount of feeding. In case of severe condition all leaves in the plants become crinkled or twisted, photosynthesis hampered and finally yield reduction occur severely. Moreover, many of these pests are potential vector of various viruses and their honeydew attracts black sooty mould which inhibits photosynthesis thus reducing the yield.

Vegetable growers are extensively depends on chemical pesticides to counter the problem of these insect pests. Indiscriminate use of pesticides has led to severe ecological consequences like destruction of natural enemy fauna, effect on non target organisms, residues in consumable products and ultimately resistance to the pesticides, to which we solely rely.

### **Endocrine biopesticides, promising alternate of conventional insecticides:**

Therefore, the current millennium demands that the pest management studies should be bio-intensive. One of the methods that emerged in recent years gaining increased attention is the use of biopesticides in order to develop environment friendly, safe and compatible approaches and tactics for sucking pest management in vegetables.

Endocrine biopesticides are certain types of pesticides those are inclusively works in the endocrine system of insects and involved in regulating insects growth and development and metamorphosis (Muraleedharan and Elayidam, 2008). Potential endocrine-biochemicals like chitin synthesis inhibitor, chitosan (a chitin-derived bio-molecule), Juvenile hormone agonist, ecdysteroid agonist, Juvenile hormone esterase etc. might play role as the potential component of IPM for sucking insect pests (Miyamoto *et al.*, 1993; Sindhu *et al.*, 2001; Gilbert *et al.*, 2000) as these molecules have more selective mode of action, rapid bio-degradability properties and reduced risks for non-target organisms and the environment. The multiple functional capacities of insect neuropeptides based on intervention on this system at any level provide opportunities for new insect control strategies for sucking insects (Couillaud *et al.*, 1995). Evaluation of novel endocrine-biopesticides those are much more specific to insect biochemical sites and that are not active to mammals need to be explored for developing eco-friendly and sustainable approach for the management of major sucking insect pests of important vegetable crops in Bangladesh.

### **Contribution in sustainable technology:**

Endocrine biopesticides viz. Buprofezin, Lufenuron, Novaluron, Chitosan etc. are new biorational molecules. These molecules will certainly contribute in the production of safe vegetables as well as development of environmental sustainability in the following ways;

**(a)** Development of resistance to various synthetic insecticides is a substantial concern. The IGRs work on the insect endocrine system, not on the digestive or nervous system and therefore, does not lead to development of resistance in future generation's that will contribute in the development of sustainable technology.

**(b)** Different synthetic insecticides potentially kill non-target or beneficial insect's while biorational molecules are safe for non-target insects.

**(c)** Synthetic insecticides are widely regarded as one of the greatest cause of contamination of surface water. As bio-insecticides are completely bio-degradable, so these are not threat for out surface water.

**(d)** The selected molecules are safe for agricultural products and protect the biological components. They are environmentally non-hazardous because of their quick bio-degradability.

**(e)** No detrimental effect on soil microorganism.

Therefore, the proposed project will potentially be contributed in the development of sustainable technology.

**7. Sub-project goal:** Effective control of major sucking insect pests of vegetables using endocrine biopesticides towards the production of safe vegetables as well as ecological sustainability.

**8. Sub-project objective (s):** The present project aims to study the potentiality of endocrine-based biochemicals against major sucking insect pests of vegetables both in the laboratory and field conditions. However, the specific objectives are:

**(a)** to evaluate the potentialities of endocrine biopesticides on the mortality as well as inhibition of growth and development of different sucking insects like jassids, aphids, white fly etc. in the laboratory condition.

**(b)** to investigate the field efficacy of selected endocrine biopesticides on the reduction of mean populations of sucking insects, percent reduction of population over control and abundances of natural enemies in vegetable-ecosystem.

**9. Implementing location (s):**

[a] Laboratory, Department of Entomology, Bangladesh Agricultural University,  
Mymensingh-2202.

[b] Entomology Field Laboratory, Bangladesh Agricultural University, Mymensingh-2202.

## 10. Methodology in brief:

### ❖ Methodology followed:

Experiments were conducted both in the laboratory as well as in the field condition to evaluate the efficacy of four endocrine biopesticides against major sucking insect pests of vegetables like okra, brinjal, country bean etc during rabi and kharif season of 2017-2018. Field experiments were conducted at “Entomology Field Laboratory” and laboratory experiments were conducted at “Laboratory of Entomology”, under Department of Entomology, Bangladesh Agricultural University, Mymensingh.

### ❖ Methodology for laboratory experiments:

- **Experimental insects:** In the laboratory condition, four endocrine biopesticides were evaluated against major sucking insect pests of vegetables like jassid, bean aphid and white fly with two concentrations of each.
- **Endocrine biopesticides:** The following biopesticides were evaluated:

Treatments	Active ingredients	Doses
Pyrifen 10.8 EC	Pyriproxifen	1.0 and 1.5 ml/L
Award 40 SC	Buprofezin	0.5 and 1.0 ml/L
Heron 5 EC	Lufenuron	1.0 and 1.5 ml/L
Chitosan	Chitosan	1.0 and 2.0 g/L

- **Mass rearing of insects:** All the insects were reared on their specific host plants in the laboratory to conduct the experiments.
- **Treatment application methods:** Treatments were applied through three application methods viz. direct, leaf-dip and combined to know the action of selected endocrine biopesticides.
  - (i) **Direct application method:** In this method, insects were treated directly and then treated insects were released on untreated leaves. Wet cotton was inserted inside the petridish to avoid desiccation of leaves.

**(ii) Leaf dip method/indirect application method:** In this method, leaves were treated with selected treatments, then air-dried thoroughly and finally untreated insects were released on treated leaves using fine brush. Wet cotton was inserted inside the petridish to avoid desiccation of leaves.

**(iii) Combined application method:** In this method, both insects and leaves were treated using selected biopesticides. Then, treated leaves were air-dried thoroughly. After that, treated insects were released on treated leaves using fine brush to avoid any injury. Wet cotton was inserted inside the petridish to avoid desiccation of leaves.

➤ **Preparation of treatment solutions:** Award 40 SC, Heron 5 EC and Pyrifen 10.8 EC solutions were prepared using distilled water with specific concentrations. On the other hand, chitosan solution was prepared using glacial acetic acid. In this case, 1% glacial acetic acid solution was prepared, then chitosan powder was mixed with solution and did vortex using 5000 rpm to mix the powder with solution.

➤ **Data collection:**

Parameters	Data collection schedule
1. Mortality of adults or nymphs	1, 3 and 7 days after treatment application.
2. Weight changes	At 7 days after treatment application.

➤ **Data analyses:** All the statistical analyses in the present study were carried out using ANOVA, followed by Fisher's least significant difference test (Fisher's LSD).  $P < 0.05$  was considered significant statistically.

❖ **Methodology for field experiments:**

- **Location:** Field experiments were conducted at the Entomology Field Laboratory, BAU, Mymensingh.
- **Experimental design:** All the field experiments were conducted in a randomized complete block design (RCBD) with three replications of each treatment.
- **Preparation of experimental plots:** Experimental plots were prepared using recommended doses of manures and fertilizers. Then seedling of brinjal was transplanted. On the other hand, seeds of country bean and okra were sown in the experimental plots. Seeds were collected from local market. Details of time of transplanting and sowing are given below:

Name of vegetable	Seed sowing time	Seedling transplantation time
Brinjal	September	October/November
Country bean	October	---
Okra	February	---

- **Specification of treatments: Following treatments sprayed in experimental plots using the specific concentration.**

Treatments	Active ingredients	Group/ Family	Doses
Pyrifen 10.8 EC	Pyriproxyfen	Juvenile Hormone Analogue	1.0 and 1.5 ml/L
Award 40 SC	Buprofezin	Chitin Synthesis Inhibitor	0.5 and 1.0 ml/L
Heron 5 EC	Lufenuron	Benzoyl-phenyl-urea chitin synthesis inhibitors	1.0 and 1.5 ml/L
Chitosan	Chitosan	Insect Growth Regulator	1.0 and 2.0 g/L

- **Details of spraying and data collection parameters:**

Vegetables	Starting of spraying	No. of sprays	Intervals of spray	Parameters of data collection	Time of observation
1. Brinjal	Once infestation appears.	3	7 days	(i) Percent reduction of jassids, and white flies. (ii) Abundances of natural enemies especially ladybird beetle after treated with selected biopesticides.	<b><u>For mortality:</u></b> 24 h before spray, 1, 3 & 7 days after each spray. <b><u>For natural enemies:</u></b> At 7 DAT
2. Okra	30-40 days after sowing seeds or once infestation appears.	3	7 days	(i) Percent reduction of jassids. (ii) Abundances of natural enemies especially ladybird beetle after treated with selected biopesticides.	<b><u>For mortality:</u></b> 24 h before spray, 1, 3 & 7 days after each spray. <b><u>For natural enemies:</u></b> At 7 DAT
3. Country Bean	30 – 40 days after seedlings transplantation or once infestation appears	3	7 days	(i) Percent reduction of available sucking insects (aphids, jassids) (ii) Abundances of natural enemies especially ladybird beetle after treated with selected biopesticides.	<b><u>For mortality:</u></b> 24 h before spray, 1, 3 & 7 days after each spray. <b><u>For natural enemies:</u></b> At 7 DAT

- **Data analyses:** All the statistical analyses in the present study were carried out using ANOVA, followed by Fisher's least significant difference test (Fisher's LSD).  $P < 0.05$  was considered significant statistically.



[A]



[B]

**Plate-1:** Mass-rearing of bean aphid [A] on country bean plants and jassids & white flies on brinjal plants [B]



**Plate-2:** Treatments were applied in the laboratory

## 11. Results and discussion:

Effects of four endocrine biopesticides viz. Award 40 SC, Heron 5 EC, Pyrifen 10.8 EC and Chitosan were evaluated both in the field and in the laboratory condition. The results were found both from laboratory and field conditions are discussed here:

### 11.1 Effect of endocrine biopesticides on the mortality and weight reduction of bean aphid

#### 11.1.1 Effects on the mortality of bean aphid

All the selected endocrine biopesticides had significant ( $P < 0.05$ ) effect on the mortality of bean aphid. Treatments were applied through direct, leaf-dip and combined application method. No significant effect was found at 1 DAT which confirms the slower action of endocrine biopesticides. The mortality level gradually increased at 3 DAT and reached to the highest level at 7 DAT (Table: 1-3). Chitosan was found to be very ineffective (20-22% mortality) compared to other treatments. The lowest mortality was found from untreated control. Among three application methods, combined method was found to be very effective which was followed by leaf-dip and direct application method respectively. From this study it has been assumed that endocrine biopesticides are capable of penetrating into the leaf tissues and for that reason mortality level increased further compared to direct application methods when insects fed treated leaves.

**Table-1:** Effect of endocrine biopesticides on the mortality of bean aphid through direct application method during 2017-2018.

Treatments	Doses	Pre-treated No.	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	2.11	35.32c	44.12c
	1.0 ml/L	15	2.21	42.12f	55.13d
Heron 5 EC	1.0 ml/L	15	2.10	45.67f	49.34e
	1.5 ml/L	15	1.16	52.12e	55.12d
Pyrifen 10.8 EC	1.0 ml/L	15	2.00	33.23d	39.34c
	1.5 ml/L	15	1.19	37.89c	44.23c
Chitosan	1.0 g/L	15	1.01	10.23b	14.23b
	2.0 g/L	15	2.10	12.12b	15.12b
Control	---	15	2.22	6.35a	8.31a
CV (%)			7.65	11.96	12.78
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \* $P < 0.05$  significant at 5% level. NS: Not significant. DAT: Days After Treatment.

**Table-2:** Effect of endocrine biopesticides on the mortality of bean aphid through leaf dip method during 2017-2018.

Treatments	Doses	Pre-treated No.	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	2.01	42.32c	53.11c
	1.0 ml/L	15	2.00	67.12f	86.13d
Heron 5 EC	1.0 ml/L	15	1.95	55.61f	59.34e
	1.5 ml/L	15	1.56	75.12e	79.34d
Pyrifen 10.8 EC	1.0 ml/L	15	2.00	52.21d	61.11c
	1.5 ml/L	15	2.56	66.81c	84.23c
Chitosan	1.0 g/L	15	2.31	15.21b	16.14b
	2.0 g/L	15	3.33	15.89b	17.31b
Control	---	15	2.22	5.31a	9.35a
CV (%)			6.90	12.91	13.21
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. NS: Not significant. DAT: Days After Treatment.

**Table-3:** Effect of endocrine biopesticides on the mortality of bean aphid, *Aphis craccivora* through combined application method during 2017-2018.

Treatments	Doses	Pre-treated No.	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	3.07	45.39c	59.19c
	1.0 ml/L	15	2.67	70.15f	89.19d
Heron 5 EC	1.0 ml/L	15	2.78	59.22f	63.21e
	1.5 ml/L	15	2.90	76.17e	83.31d
Pyrifen 10.8 EC	1.0 ml/L	15	2.67	59.22d	66.17c
	1.5 ml/L	15	3.00	71.88c	89.23c
Chitosan	1.0 g/L	15	2.56	16.26b	20.31b
	2.0 g/L	15	3.12	18.89b	22.31b
Control	---	15	3.00	7.31a	8.88a
CV (%)			6.61	12.91	10.71
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. NS: Not significant. DAT: Days After Treatment.

**11.1.2 Effects on weight reduction of bean aphid**

Award 40 SC, Heron 5 EC and Pyrifen 10.8 EC significantly reduced weight of bean aphid over control ( $P < 0.05$ , Table: 4-6). The lowest weight reduction was recorded from chitosan (5-7%). The highest was found from Award 40 SC (35-42%) which was followed by Pyrifen and Heron respectively. It was also observed that Heron 5 EC was found to be comparatively weaker to reduce growth and development of bean aphid compared to Award and Pyrifen. This might be related with the mode of action of IGRs inside the insect body. Like as mortality, combined application method was found to be stronger than other application methods.

**Table-4:** Weight reduction of bean aphid over control in topical application method during 2017-2018.

Treatments	Doses	Weight reduction of bean aphid over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	13.23a	18.67a
	1.0 ml/L	16.76a	24.42b
Heron 5 EC	1.0 ml/L	8.89b	12.23c
	1.5 ml/L	14.56a	18.89a
Pyrifen 10.8 EC	1.0 ml/L	12.23c	16.78a
	1.5 ml/L	17.23a	21.61b
Chitosan	1.0 g/L	2.23d	4.45d
	2.0 g/L	2.67f	5.55d
CV (%)		4.12	5.67
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \* $P <$  significant at 5% level. DAT: Days After Treatment.

**Table-5:** Weight reduction of bean aphid over control in leaf-dip application method during 2017-2018.

Treatments	Doses	Weight reduction of bean aphid over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	15.23a	27.43a
	1.0 ml/L	21.12b	37.34b
Heron 5 EC	1.0 ml/L	10.23c	16.77c
	1.5 ml/L	17.56a	23.81d
Pyrifen 10.8 EC	1.0 ml/L	13.21a	29.71a
	1.5 ml/L	20.54b	34.90e
Chitosan	1.0 g/L	3.34d	5.67f
	2.0 g/L	4.23d	6.67f
CV (%)		3.78	6.76
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. DAT: Days After Treatment.

**Table-6** Weight reduction of bean aphid over control in combined application method during 2017-2018.

Treatments	Doses	Weight reduction of bean aphid over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	17.21a	31.23a
	1.0 ml/L	23.45b	42.12b
Heron 5 EC	1.0 ml/L	12.33c	17.81c
	1.5 ml/L	19.01d	27.89d
Pyrifen 10.8 EC	1.0 ml/L	16.78a	32.32a
	1.5 ml/L	21.34d	39.90b
Chitosan	1.0 g/L	4.34e	6.78d
	2.0 g/L	6.05e	7.45d
CV (%)		5.65	7.18
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. DAT: Days After Treatment.

## 11.2 Effect of endocrine biopesticides on the mortality and weight reduction of okra jassids

### 11.2.1 Effects on mortality of okra jassids

All the selected endocrine biopesticides had significant ( $P < 0.05$ ) effect on the mortality of okra jassids. Treatments were applied through direct, leaf-dip and combined application method. No significant effect was found at 1 DAT which confirms the slower action of endocrine biopesticides. The mortality level gradually increased at 3 DAT and reached to the highest level at 7 DAT (Table: 7-9). Chitosan was found to be very ineffective (15-18% mortality) compared to other treatments. The lowest mortality was found from untreated control. Among three application methods, combined method was found to be very effective which was followed by leaf-dip and direct application method respectively. Award 40 SC and Pyrifen 10.8 EC were found very effective where about 90% jassids were died. Heron was found slightly weaker than Award or Pyrifen.

**Table-7:** Effects of endocrine biopesticides on the mortality of okra jassids, *Amrasca biguttula biguttula* (Ishida) through direct application method during 2017-2018.

Treatments	Doses	Pre-treated No.	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	3.12	30.58a	54.67a
	1.0 ml/L	15	4.23	42.71b	62.89b
Heron 5 EC	1.0 ml/L	15	3.43	38.90b	45.41c
	1.5 ml/L	15	5.23	55.74c	60.43b
Pyrifen 10.8 EC	1.0 ml/L	15	3.41	29.00a	50.43a
	1.5 ml/L	15	2.99	40.21b	59.92b
Chitosan	1.0 g/L	15	2.45	7.89d	9.23d
	2.0 g/L	15	3.65	10.23d	12.31d
Control	---	15	3.23	4.65e	6.76e
CV (%)			6.90	12.34	14.45
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \* $P < 0.05$  significant at 5% level. NS: Not significant. DAT: Days After Treatment.

**Table-8:** Effect of endocrine biopesticides on the mortality of okra jassids, *Amrasca biguttula biguttula* (Ishida) through leaf-dip method during 2017-2018.

Treatments	Doses	Pre-treated Number	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	3.12	35.51a	70.01a
	1.0 ml/L	15	2.67	51.71b	83.23b
Heron 5 EC	1.0 ml/L	15	3.81	60.23c	64.41a
	1.5 ml/L	15	4.21	71.54d	75.09c
Pyrifen 10.8 EC	1.0 ml/L	15	3.71	33.90a	63.10a
	1.5 ml/L	15	2.91	43.21e	81.12b
Chitosan	1.0 g/L	15	3.41	11.21f	14.45d
	2.0 g/L	15	3.99	12.34f	15.45d
Control	---	15	3.23	5.61g	7.51e
CV (%)			2.32	6.78	7.23
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. NS: Not significant. DAT: Days After Treatment.

**Table-9:** Effect of endocrine biopesticides on the mortality of okra jassids, *Amrasca biguttula biguttula* (Ishida) through combined application method during 2017-2018.

Treatments	Doses	Pre-treated No.	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	2.66	37.55a	74.11a
	1.0 ml/L	15	3.21	55.67b	87.21b
Heron 5 EC	1.0 ml/L	15	3.46	66.21c	69.02c
	1.5 ml/L	15	4.21	74.44c	78.01b
Pyrifen 10.8 EC	1.0 ml/L	15	3.44	40.22a	67.10c
	1.5 ml/L	15	3.91	53.27b	87.12b
Chitosan	1.0 g/L	15	3.41	11.29d	15.77d
	2.0 g/L	15	3.15	14.31d	18.41d
Control	---	15	3.61	5.93e	7.54e
CV(%)			3.12	6.67	8.23
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. NS: Not significant. DAT: Days After Treatment.

### 11.2.2 Effects on weight reduction of okra jassids

Award 40 SC, Heron 5 EC and Pyrifen 10.8 EC significantly reduced weight of okra jassids over control ( $P < 0.05$ , Table: 10-12). The lowest weight reduction was recorded from chitosan (5-7%). The highest was found from Award 40 SC (35-40%) which was followed by Pyrifen and Heron respectively. It was also observed that Heron 5 EC was found to be comparatively weaker to reduce growth and development compared to Award and Pyrifen. This might be related with the mode of action of IGRs in the insect body. Like as mortality, combined application method was found to be stronger than other application methods.

**Table- 10:** Weight reduction of okra jassids over control in topical application method during 2017-2018.

Treatments	Doses	Weight reduction of jassid over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	11.21a	14.61a
	1.0 ml/L	14.71a	21.12b
Heron 5 EC	1.0 ml/L	8.81b	10.21a
	1.5 ml/L	12.51a	14.81a
Pyrifen 10.8 EC	1.0 ml/L	10.21a	12.71a
	1.5 ml/L	13.23a	18.61b
Chitosan	1.0 g/L	3.21c	4.13c
	2.0 g/L	2.63c	4.95c
CV (%)		5.78	7.23
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \* $P <$  significant at 5% level. DAT: Days After Treatment.

**Table-11:** Weight reduction of okra jassids over control in leaf-dip application method during 2017-2018.

Treatments	Doses	Weight reduction of jassid over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	12.00a	24.68a
	1.0 ml/L	10.71a	37.12b
Heron 5 EC	1.0 ml/L	9.81a	18.21c
	1.5 ml/L	14.53b	27.00a
Pyrifen 10.8 EC	1.0 ml/L	13.22b	25.00a
	1.5 ml/L	15.21b	34.55b
Chitosan	1.0 g/L	4.67c	7.45d
	2.0 g/L	5.67c	9.01d
CV (%)		5.02	7.71
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. DAT: Days After Treatment.

**Table-12:** Weight reduction of okra jassids over control in combined application method during 2017-2018.

Treatments	Doses	Weight reduction of jassid over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	14.00a	26.61a
	1.0 ml/L	12.74a	40.00b
Heron 5 EC	1.0 ml/L	11.11a	20.40a
	1.5 ml/L	15.65a	30.45a
Pyrifen 10.8 EC	1.0 ml/L	15.22a	25.00a
	1.5 ml/L	21.21b	37.40b
Chitosan	1.0 g/L	4.88c	7.90c
	2.0 g/L	6.23c	9.45c
CV (%)		4.24	5.61
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. DAT: Days After Treatment.

### 11.3 Effect of endocrine biopesticides on the mortality and weight reduction of white fly

#### 11.3.1 Effects on mortality of white fly

Like as bean aphid and okra jassids, similar results were also found in case of white fly (Table-13,  $P < 0.05$ ). Only leaf-dip method was applied in case of white fly due to handling difficulties. Award, Pyrifen and Heron had significant effect on the mortality of white fly while where  $>80\%$  white flies were died. Lower concentrations were found to be less effective than higher concentrations. In contrast, chitosan was found to be very ineffective where only 12-13% insects were died. The lowest mortality was found from untreated control.

#### 11.3.2 Effects on weight reduction of white fly

Except chitosan, the rest of the three endocrine biopesticides had significant effect on the reduction of weight of white fly (Table-14). Only 4-5% growth and development was arrested when white fly populations were treated with chitosan. There had insignificant differences between two doses of chitosan. On the other hand, 20-30% weight reduction was observed when white fly populations were treated with either Award or Pyrifen. Lesser effect was found from Heron compared to Award or Pyrifen.

**Table-13:** Effect of endocrine biopesticides on the mortality of white fly through leaf dip method during 2017-2018.

Treatments	Doses	Pre-treated No.	Mortality (%) at different DAT		
			1 DAT	3 DAT	7 DAT
Award 40 SC	0.50 ml/L	15	4.22	31.34a	65.45a
	1.0 ml/L	15	5.23	53.71b	93.34b
Heron 5 EC	1.0 ml/L	15	3.89	55.67b	67.89a
	1.5 ml/L	15	4.27	65.78c	75.02a
Pyrifen 10.8 EC	1.0 ml/L	15	4.56	36.89a	67.14a
	1.5 ml/L	15	5.89	47.21d	89.34b
Chitosan	1.0 g/L	15	2.56	10.45e	13.56c
	2.0 g/L	15	3.91	12.87e	15.41c
Control	---	15	3.00	5.11f	7.88d
CV (%)			2.32	6.77	8.32
P-Level			NS	*	*

Means of similar letter (s) in a column do not differ significantly. \* $P <$  significant at 5% level. NS: Not significant. DAT: Days After Treatment.

**Table-14:** Weight reduction of white fly over control in leaf dip method during 2017- 2018.

Treatments	Doses	Weight reduction (%) of white fly over control at different DAT	
		3 DAT	7 DAT
Award 40 SC	0.5 ml/L	8.89a	21.34a
	1.0 ml/L	11.56b	33.45b
Heron 5 EC	1.0 ml/L	7.45a	17.89a
	1.5 ml/L	12.44b	24.01a
Pyrifen 10.8 EC	1.0 ml/L	12.78b	21.02a
	1.5 ml/L	14.91b	32.12b
Chitosan	1.0 g/L	4.44c	7.78c
	2.0 g/L	5.61c	8.34c
CV (%)		4.41	5.66
P-level		*	*

Means of similar letter (s) in a column do not differ significantly. \*P< significant at 5% level. DAT: Days After Treatment.

#### **11.4 Effect of endocrine biopesticides on the incidence of bean aphid, jassids and white fly in field condition.**

##### ***11.4.1 Effect of IGRs on the incidence of bean aphid on country bean***

To validate the laboratory performances of selected endocrine biopesticides, field investigation was carried out. Data clearly showed that Award 40 SC, Pyrifen 10.8 EC and Heron 5 EC significantly reduced the incidence of bean aphid populations compared to control (Table-15,  $P < 0.05$ ). The highest population was recorded from untreated control plot (17.89/leaf). This incidence was reduced potentially when bean plants were treated with Award, Pyrifen or Heron. These three IGRs showed similar and potential effects on the reduction of aphid populations in field. It was also found that bean aphid populations were gradually decreased with increasing spray numbers i.e. the effect of IGRs was found to be consistent against bean aphid (Table-16). There had no significant effect of chitosan on the reduction aphid populations in the field condition compared to control (17.89 vs. 15.78). Figure 1 clearly showed that bean aphid populations were reduced to 1-2/leaf at three weeks after treatment application (Fig.1). In contrast, there had insignificant difference between the effect of chitosan and untreated control.

##### ***11.4.1 Effect of IGRs on the incidence of jassid and white fly on brinjal***

Similar trend was found in case of jassids and white fly following treated with selected IGRs. The highest numbers were recorded from untreated control which was comparable with chitosan with both of the doses. On the other hand, Award, Pyrifen and Heron had similar and potential effects on the reduction of jassid or white fly populations on brinjal leaves compared to control (Table- 17 & 19). It was also found that insect abundances gradually decreased with increasing number of sprays and lowest numbers were found from 3<sup>rd</sup> sprays. This result confirms the consistency of efficacy of selected IGRs against jassids or white flies (Table-18 & 20). Moreover, jassid and white fly populations were reduced to 1-2/leaf at three weeks after treatment application. In contrast, chitosan had insignificant effect on the reduction of jassid or white fly populations (Figs. 2 & 3).

**Table-15** Efficacy of endocrine biopesticides on the incidence of bean aphid on country bean during rabi season, 2017-2018 at BAU.

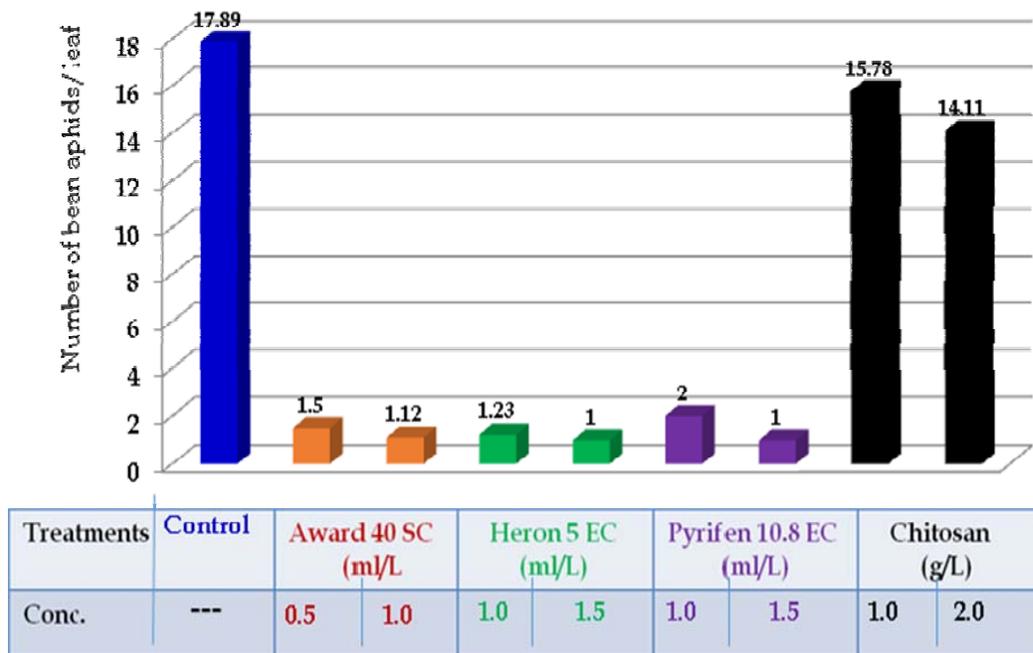
Treatments	Pre-treated number	Mean number of aphid populations/leaf								
		Days after 1 <sup>st</sup> spray			Days after 2 <sup>nd</sup> spray			Days after 3 <sup>rd</sup> spray		
		1	3	7	1	3	7	1	3	7
Award 40 SC @ 0.50 ml/L	5.14	4.23	3.23a	4.00a	3.11a	3.23a	3.13a	3.78a	3.41a	1.50a
Award 40 SC @ 1.0 ml/L	5.67	4.11	3.15a	3.00b	2.56b	2.12b	1.78b	1.00b	1.21b	1.12b
Heron 5 EC @ 1.0 ml/L	5.00	5.23	4.67b	4.12a	3.23a	3.45a	2.98c	2.56c	2.00b	1.23ab
Heron 5 EC @ 1.5 ml/L	4.44	4.67	4.00b	3.65b	3.01a	2.56b	2.23c	2.00cd	1.53b	1.00b
Pyrifen 10.8 EC @ 1.0 ml/L	5.31	5.11	5.23c	3.12b	3.22a	3.74a	2.67c	2.23c	2.12b	2.00c
Pyrifen 1.5 ml/L @ 1.5 ml/L	4.94	4.01	4.45b	3.00b	2.90a	2.19b	2.00c	1.56d	1.34b	1.00b
Chitosan 1.0 g/L	5.12	5.45	5.00c	7.71c	8.11c	7.78c	9.45d	11.34e	12.21d	15.78d
Chitosan 2.0 g/L	5.34	5.10	4.55c	7.68c	8.00c	7.45c	9.00d	11.01e	11.20c	14.11d
Control	5.23	5.56	4.45c	7.78c	8.23c	8.00c	10.23d	12.31e	15.61d	<b>17.89d</b>
CV (%)	3.34	5.66	6.21	7.23	8.23	8.45c	8.45	9.11	10.17	<b>12.11</b>
P-level	NS	NS	*	*	*	*	*	*	*	*

[\*P<0.05, NS: Not Significant; In a column, means of similar letter (s) do not differ significantly]

**Table-16:** Relative incidence of aphid populations in different sprayings following treated with selected treatments during rabi season, 2017-2018 at BAU.

Sprays	Buprofezin		Heron		Pyrifen		Chitosan		Control
	0.5 ml/L	1.0 ml/L	1.0 ml/L	1.5 ml/L	1.0 ml/L	1.5 ml/L	1.0 g/L	2.0 g/L	
1 <sup>st</sup> spray	3.82a	3.42a	4.67a	4.10a	4.49a	3.82a	6.05a	5.78a	5.08a
2 <sup>nd</sup> spray	3.16a	2.15b	3.22b	2.60b	3.21b	2.36b	8.44b	8.15b	8.82b
3 <sup>rd</sup> spray	2.90b	1.11c	1.93c	1.51a	2.12c	1.30c	13.11c	12.11c	15.27c
Mean	3.29	2.22	3.27	2.74	3.27	2.49	9.20	8.68	<b>9.72</b>
CV (%)	3.12	2.34	3.67	4.51	4.22	4.67	5.41	5.55	6.78
P-Level	*	*	*	*	*	*	*	*	*
% reduction over control	66.15	77.16	66.35	71.81	66.35	74.38	5.35	10.69	---

[\*P<0.05, In a column, means of different letter (s) differ significantly]



**Fig. 1** Number of bean aphids/per leaf at 3 weeks after treatment application

**Table-17** Efficacy of endocrine biopesticides on the incidence of jassid populations on brinjal during rabi season, 2017-2018 at BAU.

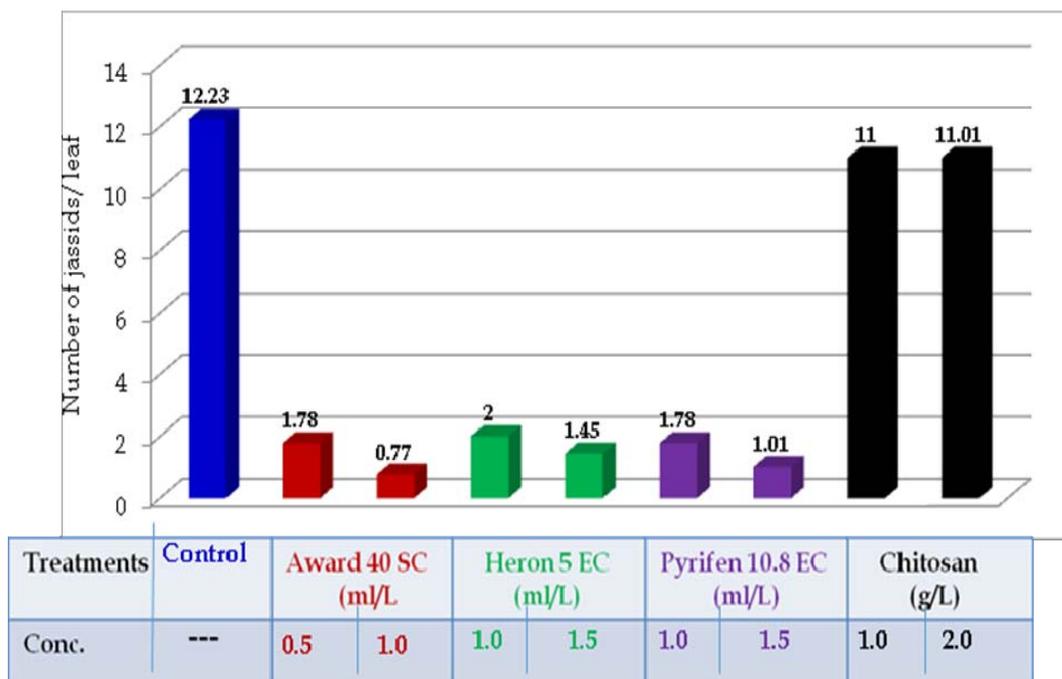
Treatments	Pre-treated number	Mean number of jassid populations/leaf								
		Days after 1 <sup>st</sup> spray			Days after 2 <sup>nd</sup> spray			Days after 3 <sup>rd</sup> spray		
		1	3	7	1	3	7	1	3	7
Award 40 SC @ 0.50 ml/L	5.67	5.61	6.00a	5.12a	4.33a	4.01a	3.45a	3.00a	2.56a	1.78a
Award 40 SC @ 1.0 ml/L	4.89	4.89	5.23b	4.00b	3.11b	2.56b	2.00b	2.12b	1.56b	0.77b
Heron 5 EC @ 1.0 ml/L	6.00	5.67	6.00a	4.55b	4.01a	3.55a	3.02c	3.24a	2.45a	2.00a
Heron 5 EC @ 1.5 ml/L	5.34	5.37	5.23b	5.11a	4.00a	3.01b	2.85c	2.67b	2.00b	1.45c
Pyrifen 10.8 EC @ 1.0 ml/L	4.78	5.60	4.00c	4.55b	3.78a	3.66b	2.41b	2.33b	2.02b	1.78a
Pyrifen 1.5 ml/L @ 1.5 ml/L	5.71	5.60	5.11b	4.11b	3.00b	2.51c	2.88c	2.01b	1.34b	1.01b
Chitosan 1.0 g/L	6.12	6.11	6.01a	6.88c	8.01c	8.55d	7.34d	7.44c	8.21c	11.00d
Chitosan 2.0 g/L	5.39	5.31	5.23b	6.78c	7.88c	8.00d	7.45d	7.11c	8.23c	11.01d
Control	5.82	5.72	6.78d	7.34d	8.45c	7.34d	7.89d	7.56c	8.90c	12.23d
CV (%)	3.01	3.22	4.02	5.22	5.43	5.61	6.67	6.45	7.81	8.90
P-level	NS	NS	*	*	*	*	*	*	*	*

[\*P<0.05, NS: Not Significant; In a column, means of similar letter (s) do not differ significantly]

**Table-18:** Relative incidence of jassid populations in different sprayings following treated with selected treatments during rabi season, 2017-2018 at BAU.

Sprays	Buprofezin		Heron		Pyrifen		Chitosan		Control
	0.5 ml/L	1.0 ml/L	1.0 ml/L	1.5 ml/L	1.0 ml/L	1.5 ml/L	1.0 g/L	2.0 g/L	--
1 <sup>st</sup> spray	5.58a	4.71a	5.41a	5.24a	4.72a	4.94a	6.00a	5.77a	6.61a
2 <sup>nd</sup> spray	3.93b	2.56b	3.53b	3.29b	3.28b	2.80b	7.97b	7.78b	6.89a
3 <sup>rd</sup> spray	2.45c	1.48c	2.56c	2.04c	2.04c	1.45c	8.88b	8.78b	9.56b
<b>Mean</b>	4.02	2.91	3.83	3.52	3.34	3.06	7.61	7.44	7.67
CV (%)	3.11	3.41	4.04	4.43	5.01	5.34	5.12	6.23	6.45
P-Level	*	*	*	*	*	*	*	*	*
% reduction over control	47.58	62.05	50.06	54.10	56.54	60.10	1.82	2.99	----

[\*P<0.05, In a column, means of different letter (s) differ significantly]



**Fig. 2** Number of jassid populations /per brinjal leaf at 3 weeks after treatment application

**Table-19** Efficacy of endocrine biopesticides on the incidence of white fly populations on brinjal during rabi season, 2017-2018 at BAU.

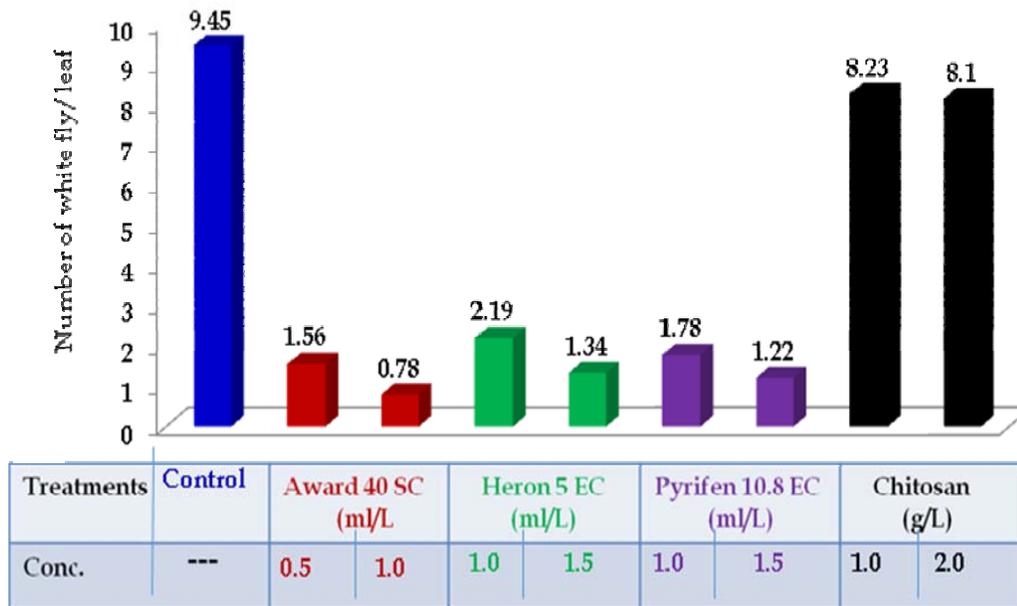
Treatments	Pre-treated number	Mean number of white fly populations/leaf								
		Days after 1 <sup>st</sup> spray			Days after 2 <sup>nd</sup> spray			Days after 3 <sup>rd</sup> spray		
		1	3	7	1	3	7	1	3	7
Award 40 SC @ 0.50 ml/L	4.12	5.61	4.21a	3.67a	3.22a	3.00a	2.51a	2.51a	2.30a	1.56a
Award 40 SC @ 1.0 ml/L	4.00	4.23	4.01a	3.41a	3.00a	2.56a	2.22a	2.31a	1.23b	0.78b
Heron 5 EC @ 1.0 ml/L	3.56	4.00	3.45a	3.78a	3.44a	3.51ab	3.00c	2.88b	2.77a	2.19a
Heron 5 EC @ 1.5 ml/L	3.78	4.03	3.44a	3.01a	2.67b	2.12c	2.00a	2.23a	1.78b	1.34c
Pyrifen 10.8 EC @ 1.0 ml/L	3.82	4.78	4.23a	3.77a	3.45a	3.78b	2.51a	2.33a	2.11a	1.78a
Pyrifen 1.5 ml/L @ 1.5 ml/L	4.23	4.01	4.11a	3.10a	2.33b	2.12a	2.00a	1.23c	1.67b	1.22c
Chitosan 1.0 g/L	4.41	4.55	5.67b	6.51b	6.20c	6.50d	7.11d	7.41d	7.80c	8.23d
Chitosan 2.0 g/L	3.88	4.23	5.50b	6.23b	6.00c	6.11d	6.50d	7.33d	7.67c	8.10d
Control	4.55	4.50	6.12c	6.50b	6.23c	6.66d	7.45d	7.81d	8.12c	9.45e
CV (%)	2.67	3.41	3.78	3.67	4.78	4.90	5.51	5.66	6.34	6.87
P-Level	NS	NS	*	*	*	*	*	*	*	*

[\*P<0.05, NS: Not Significant; In a column, means of similar letter (s) do not differ significantly]

**Table-20:** Relative incidence of white fly populations in different sprayings following treated with selected treatments during rabi season, 2017-2018 at BAU

Sprays	Buprofezin		Heron		Pyrifen		Chitosan		Control
	0.5 ml/L	1.0 ml/L	1.0 ml/L	1.5 ml/L	1.0 ml/L	1.5 ml/L	1.0 g/L	2.0 g/L	--
1 <sup>st</sup> spray	4.83a	3.88a	3.74a	3.49a	4.26a	3.74a	5.58a	5.32a	5.71a
2 <sup>nd</sup> spray	2.91b	2.59b	3.32a	2.26b	3.25b	2.15b	6.60a	6.78b	6.78b
3 <sup>rd</sup> spray	2.12c	1.44c	2.61b	1.78c	2.07c	1.37c	7.81a	7.70b	8.46c
Mean	3.29	2.64	3.22	2.51	3.19	2.42	6.66	6.60	<b>6.98</b>
CV (%)	3.11	3.50	3.23	4.12	4.67	4.23	3.67	3.50	3.01
P-Level	*	*	*	*	*	*	*	*	*
% reduction over control	52.86	62.17	53.86	64.04	54.29	65.32	4.58	5.44	----

[\*P<0.05, In a column, means of different letter (s) differ significantly]



**Fig. 3 Number of white fly/leaf at 3 weeks after treatment application**

## 11.5 Effect of endocrine biopesticides on the reduction of curled leaf of brinjal and okra

### 11.5.1 Effect of endocrine biopesticides on the reduction of curled leaf of brinjal

Selected endocrine biopesticides viz. Buprofezin, Lufenuron and Pyriproxifen had significant effect ( $P < 0.01$ ) on the reduction of curled leaf compared to untreated control (Fig.4). At 40 days after seedling transplantation (DAST), there had about 5-6% of curled leaf and this percent gradually increased with increasing time in untreated condition and reached to about 35% at 68 DAST. But when Buprofezin (Award 40SC) was applied @ 0.5 and 1.0 ml/L, percent reduction of curled was gradually decreased. About 8% curled leaf was recorded when brinjal plants were treated with Buprofezin @ 1.0 ml/L at 68 DAST which was closely followed by 0.5 ml/L of Buprofezin. Similar results were found incase of Lufenuron and Pyriproxifen. In contrast, Chitosan had no any significant effect on the reduction of curled leaf in comparison with that in the untreated control.

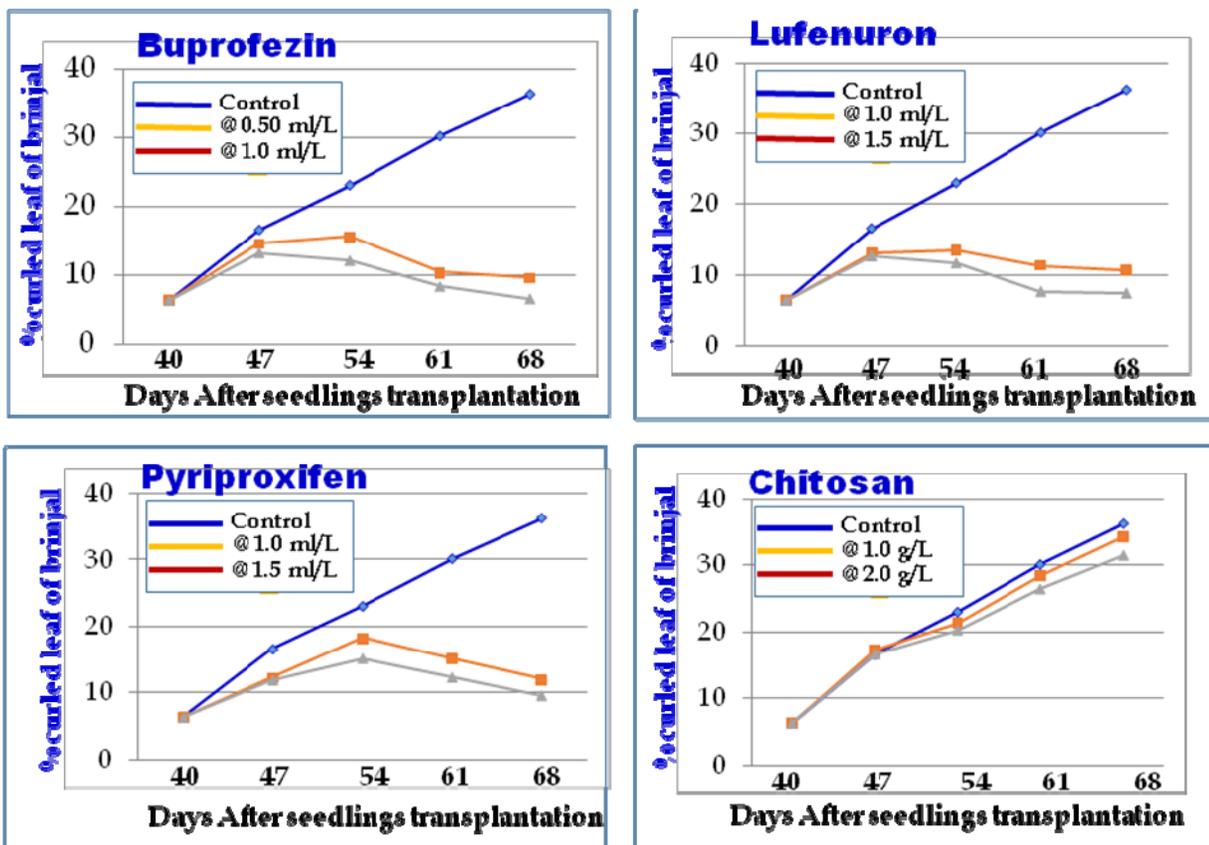


Fig. 4 Effect of endocrine biopesticides on the reduction of curled leaf of brinjal.

### 11.5.2 Effect of endocrine biopesticides on the reduction of curled leaf of okra

Another experiment was conducted on okra to see the consistency of brinjal experiments. This experiment confirmed that selected endocrine biopesticides viz. Buprofezin, Lufenuron and Pyriproxifen had significant effect ( $P < 0.01$ ) on the reduction of curled leaf of okra compared to untreated control (Fig.5). At 25 days after seedling transplantation (DAST), there about 5-7% of curled leaf and this percent gradually increased with increasing time in untreated condition and reached to about 62%. But when Buprofezin (Award 40SC) was applied @ 0.5 and 1.0 ml/L, percent reduction of curled was gradually decreased. About 12% curled leaf was recorded when okra plants were treated with Buprofezin @ 1.0 ml/L at 53 DAST which was closely followed by 0.5 ml/L of Buprofezin. Similar results were found incase of Lufenuron and Pyriproxifen. In contrast, Chitosan had no any significant effect on the reduction of curled leaf in comparison with that in the untreated control.

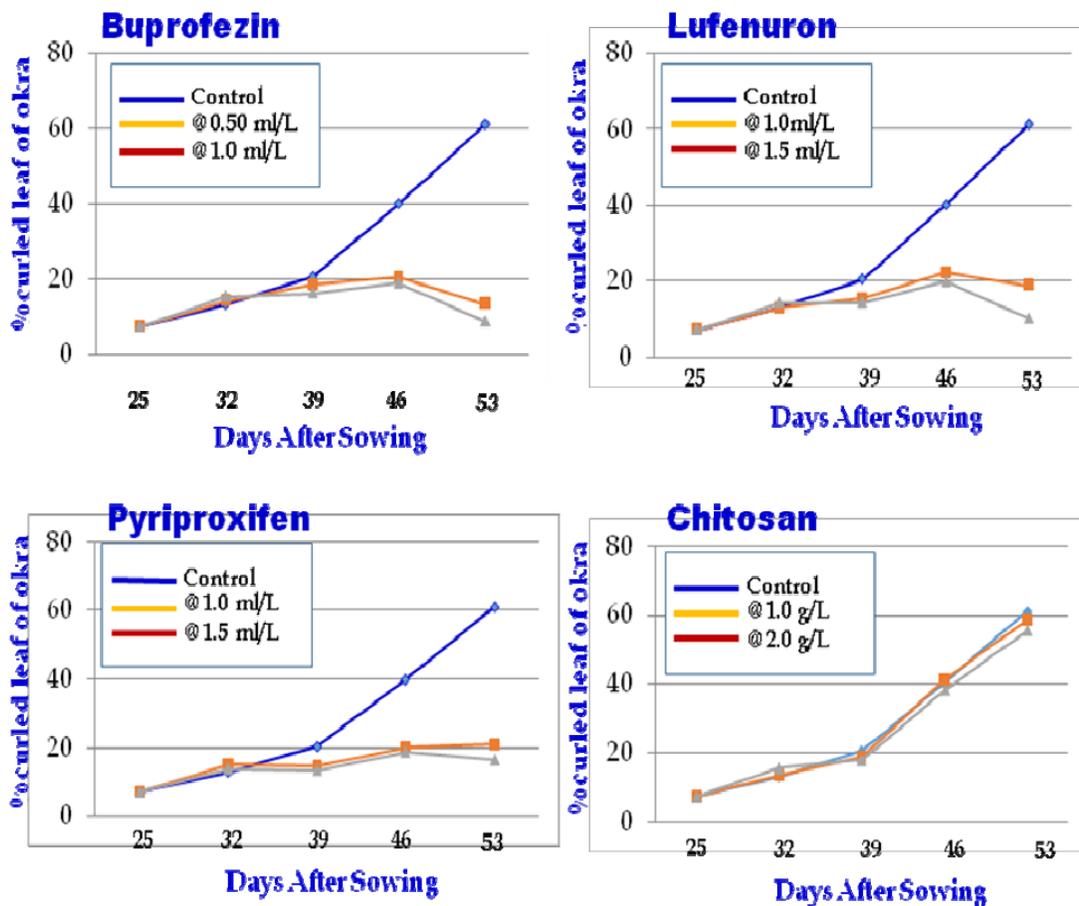


Fig.5 Effect of endocrine biopesticides on the reduction of curled leaf of okra.

### 11.6 Effect of endocrine biopesticides on the abundances of natural enemies in brinjal eco-system

An experiment was conducted to see the toxic effect of selected endocrine biopesticides on the abundances of natural enemies like ladybird beetle, lynx spiders, wolf spiders etc. Along with this cypermethrin was applied as positive control to compare with endocrine biopesticides. Result clearly showed that all the selected endocrine biopesticides had no any toxic effect on the abundances of natural enemies in brinjal ecosystem as populations were found similar with untreated control (Fig. 6). In contrast, about 80-90% natural enemies were died when brinjal plants were treated with cypermethrin @ 1.0 ml/L. Therefore, it is concluded that all the selected endocrine biopesticides were found to be very eco-friendly and safe for natural enemies in the field.

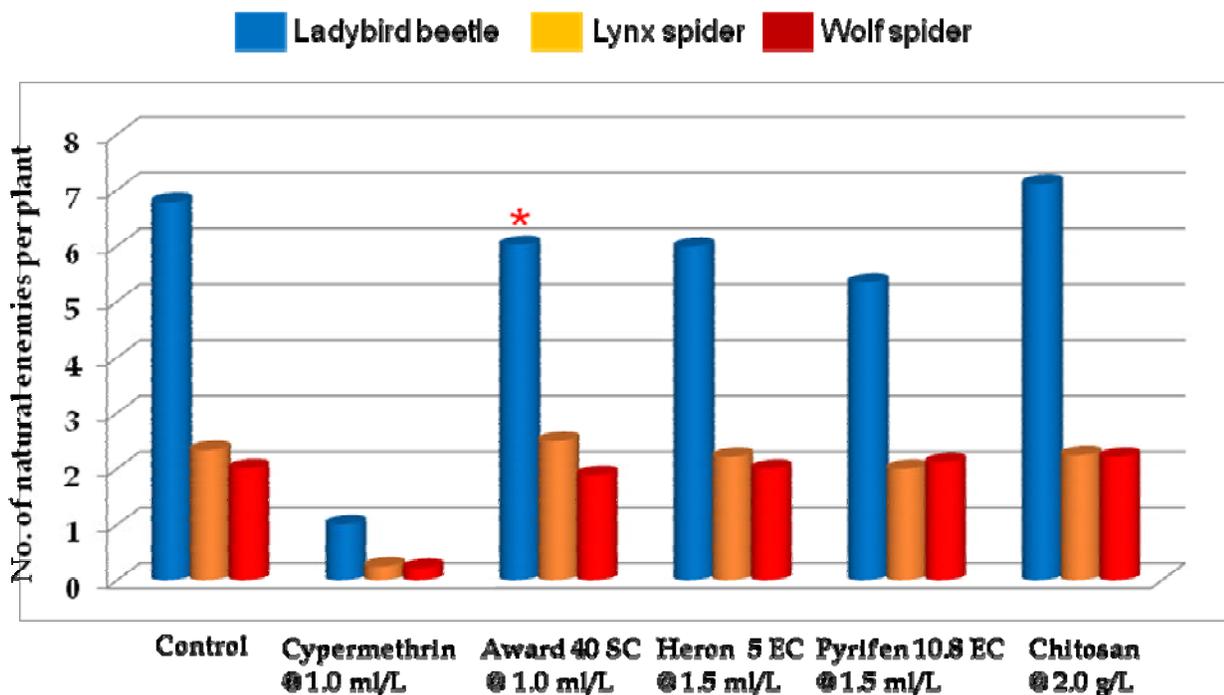


Fig. 6 Effect of tested endocrine biopesticides on the abundances of natural enemies in brinjal ecosystem.

## 12. Research highlight/findings:

- Except Chitosan all the tested endocrine biopesticides had significant effect on the mortality of sucking insects like jassid, aphids and white fly. About 30-40% mortality were found in laboratory condition at 3 days after treatment (DAT) application while mortality level reached to about 80-90% at 7 DAT which indicates that endocrine biopesticides offers slower action compared to conventional insecticides. Almost no mortality was found at 1 DAT.
- Tested endocrine biopesticides viz. Buprofezin, Lufenuron and Pyriproxifen had significant effect on the inhibition of growth and development of selected sucking insects. About 40% weight reduction was observed at 7 DAT when jassids, white fly or aphids were treated with selected endocrine biopesticides. Chitosan had no any significant effect.
- Higher mortality was found in case of leaf-dip or combined application method than topical method which indicates that endocrine biopesticides has potential translaminar action.
- About 80-85% sucking insect populations were reduced due to the application of Buprofezin, lufenuron and Pyriproxifen in the field condition.
- Chitosan was found to be ineffective against sucking insects in field condition and this result is consistent with laboratory findings.
- Infested or curled leaves (%) were reduced potentially when brinjal or okra plants were treated with selected endocrine biopesticides.
- Endocrine biopesticides were found to be safe and eco-friendly for natural enemies in brinjal or okra ecosystem.
- Finally, it can be concluded that the endocrine biopesticides viz. Buprofezin, Lufenuron and Pyriproxifen might be the potential alternatives of conventional insecticides to control sucking insects like jassids, aphids, white fly on different vegetables like brinjal, okra, tomato etc.



**Plate-3:** Country bean plants at vegetative stage in the field. The experiment was conducted at Entomology Field Laboratory, BAU, during rabi season, 2017-2018.



**Plate-4:** Country bean plants at fruiting stage in the field. The experiment was conducted at Entomology Field Laboratory, BAU, during rabi season, 2017-2018.



**Plate-5:** A treated plot with endocrine biopesticides



**Plate-6:** Untreated plot (Severely curled leaves)



**Plate-7:** A severely infested (curled leaves) brinjal plant caused by sucking insects



**Plate-8:** White flies on the ventral sides of brinjal leaf



**Plate-9:** Jassids on the ventral sides of the brinjal leaf.



**Plate-10:** Collection of data by a student



**Plate-11:** Brinjal field at fruiting stage. The experiment was conducted at Entomology Field Laboratory, BAU, during rabi season, 2017-2018.

## **B. Implementation Position**

### **1. Procurement:**

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	Laptop computer	50000.00	Laptop computer	50000.00	
(b) Lab & field equipment	Light incubator	300000.00	Light incubator	300000.00	
(c) Other capital items	Furnitures	55000.00	Furnitures	55000.00	

### **2. Establishment/renovation facilities: Not applicable**

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

### **3. Training/study tour/ seminar/workshop/conference organized:**

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					

## **C. Financial and physical progress**

**Fig in Tk**

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	378235	378235	378235	00	100	
B. Field research/lab expenses and supplies	604000	604000	604000	00	100	
C. Operating expenses	124900	124900	124900	00	100	
D. Vehicle hire and fuel, oil & maintenance	--	--	--	--	--	
E. Training/workshop/seminar etc.	--	--	--	--	--	
F. Publications and printing	79000	19000	19000	00	30	
G. Miscellaneous	--	--	--	--	--	
H. Capital expenses	405000	405000	405000	00	100	

**D. Achievement of Sub-project by objectives: (Tangible form)**

<b>Specific objectives of the sub-project</b>	<b>Major technical activities performed in respect of the set objectives</b>	<b>Output (i.e. product obtained, visible, measurable)</b>	<b>Outcome(short term effect of the research)</b>
1. To study the effect of endocrine biopesticides on the mortality of sucking insects like jassids, white fly and aphids.	1. Mass-rearing of selected insects were done in the laboratory to conduct mortality bio-assay.	1. About 80-90% sucking insects were died following treatment application.	1. Endocrine biopesticides except Chitosan are potential IGRs against sucking insects.
2. To study the effect of endocrine biopesticides on the inhibition of growth and development of sucking insects.	2. Mass-rearing of selected insects were done in the laboratory to conduct mortality bio-assay.	2. About 40% weight reduction was occurred when sucking insects were treated with selected biopesticides.	2. IGRs i.e. endocrine biopesticides (except chitosan) have potential effect on the inhibition of growth and development of jassids, aphids and white fly.
3. To study the percent reduction of sucking insects over control in field condition.	3. Brinjal, okra and country bean were cultivated in the field condition to conduct experiments.	3. About 65-70% jassids, aphids and white fly populations were reduced over control in the field condition.	3. Buprofezin, Lufenuron and Pyriproxifen have potential and significant effect on reduction of sucking insects like jassids, aphids, white fly etc in the field condition.
4. Toxic effect of endocrine biopesticides on the abundances of natural enemies in vegetable-ecosystem.	4. Brinjal, okra and country bean were cultivated in the field condition to conduct experiments.	4. Almost no or little changes were found of natural enemies even application of selected IGRs compared to untreated control.	4. Endocrine biopesticides are found to be safe and eco-friendly for natural enemies like ladybird beetle, lynx spiders, wolf spiders etc in vegetable ecosystem.

**E. Materials Development/Publication made under the Sub-project:**

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.	--	--	
Journal publication	03	--	<p><b>Proposed title:</b></p> <p>1.Effect of endocrine biopesticides on the mortality and growth inhibition of jassids in laboratory condition.</p> <p>2.Effect of endocrine biopesticides on the mortality and growth inhibition of bean aphids and white fly in laboratory condition.</p> <p>3. Evaluation of field efficacy of endocrine biopesticides on the reduction of sucking insects.</p>
Information development	--	--	Endocrine biopesticides like Buprofezin, Lufenuron and Pyriproxifen can be used successfully in the field level to control sucking insects like jassids, aphids and white fly.
Other publications, if any	--	--	--

**F. Technology/Knowledge generation/Policy Support (as applied):**

**i. Generation of technology (Commodity & Non-commodity)**

**ii. Generation of new knowledge that help in developing more technology in future**

Application of endocrine biopesticides (IGRs) like Buprofezin, Lufenuron and Pyriproxifen against sucking insects like jassids, aphid and white fly might be the potential alternate of conventional insecticides in the field level.

**iii. Technology transferred that help increased agricultural productivity and farmers' income**

**iv. Policy Support**

**G. Information regarding Desk and Field Monitoring**

**i) Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):**

- (a) A desk monitoring was done by PIU-BARC-NATP-2 team on 07.03.2018 that was led by Dr. Mian Sayeed Hassan, director, project implementation unit (PIU), BARC. According to the comments of monitoring team, the project was going on rightly and scheduled based.
- (b) Research progress was presented in the six month progress workshop (15-16 May, 2018) that was presented on 15 May, 2018 at BARC auditorium.
- (c) One year research progress was presented in the Annual Workshop (10-13, September) on 12 September, 2018 at BARC auditorium.

**ii) Field Monitoring (time& No. of visit, Team visit and output):**

- (a) Two internal field monitoring was done by Bangladesh Agricultural University Research System (BAURES) team on March 03, 2018 and 17 May, 2018. Members of the monitoring team expressed their opinion as – highly satisfied.

**I. Lesson Learned/Challenges (if any)**

- i) Large-scale research studies provided the best means of evaluating practical, replicable approaches to improving laboratory and field research knowledge.
- ii) Learnt about data collection, preparation and presentation in scientific meeting.
- iii) Learnt about management and proper expenditure of financial budget.
- iv) Learnt about preparation and submission of scientific report.

**J. Challenges (if any)**

- i) Releasing of fund was very slow and irregular that hampered the research activities.

Signature of the Principal Investigator  
Date: 01.10.2019  
Seal

Counter signature of the Head of the  
organization/authorized representative  
Date: 01.10.2019  
Seal